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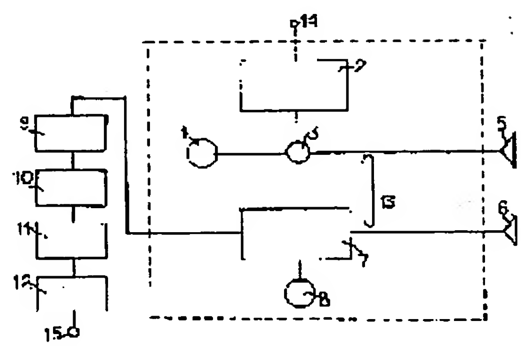
(71)Applicant : SHARP CORP
(72)Inventor : KUROKI HIROSHI
SUGIOKA MASAYUKI
SATO HIROYA

(54) MILLIMETRIC WAVE RADAR

(57)Abstract:
PROBLEM TO BE SOLVED: To obtain a millimetric wave radar in which a short distance can be detected with high accuracy while keeping a maximum distance by detecting the distance to an object based on a signal received by an antenna for receiving a reflected wave from the object.
SOLUTION: The millimetric wave radar comprises a first millimetric wave oscillator 1, a modulator 2 for pulse modulating an oscillation signal from the first millimetric wave band oscillator 1, an antenna 5 for transmitting the oscillation output from the first millimetric wave band oscillator 1, and an antenna 6 for receiving a reflected wave from an object and detects the distance to the object based on a signal received by the receiving antenna 6. The millimetric wave radar comprises a millimetric wave band oscillator 1, a pulse modulator 2, a circulator 3, a transmission antenna 5, a receiving antenna 6, a mixer 7, a local oscillator 8, an IF amplifier 9, a variable gain amplifier 10, a detector 11, and a base band amplifier 12. Furthermore, a directivity coupler 13 for introducing a part of the transmission signal to the mixer 7 is provide in the vicinity of the transmission antenna 5 and the receiving antenna 6.



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CLAIMS

[Claim(s)]
[Claim 1] the 1st millimeter wave band oscillator -- this -- the millimeter wave radar characterized by detecting the distance to said detection body with the signal received with the transmitting antenna which transmits the oscillation output of the pulse modulator which carries out pulse modulation of the oscillation signal from the 1st millimeter wave band oscillator, and said 1st millimeter wave band oscillator, the receiving antenna which receives the reflected wave from a detection body, and this receiving antenna.
[Claim 2] Said pulse modulator is a millimeter wave radar according to claim 1 characterized by being constituted by high-speed operation components, such as a 2 terminal semiconductor device like a schottky-barrier diode, or FET (field effect transistor), a 3 terminal semiconductor device like HEMT (high electron mobility transistor).
[Claim 3] Said input signal is a millimeter wave radar according to claim 1 characterized by carrying out a mixer, measuring the time difference of a transmission wave pulse and a received wave pulse from the output of said mixer, and measuring the distance from this time difference to a detection body with the 2nd oscillation signal and mixer of a millimeter wave band oscillator.
[Claim 4] Said 1st millimeter wave band oscillator, a pulse modulator, a transmitting antenna, a receiving antenna, the 2nd millimeter wave band oscillator, and a mixer are a millimeter wave radar according to claim 1 characterized by a NRD guide (nonradioactive dielectric wire way) connecting.
[Claim 5] The millimeter wave radar characterized by consisting of a transceiver antenna which transmits the oscillation output of a millimeter wave band oscillator, the pulse modulator which carries out pulse modulation of the output of this millimeter wave band oscillator, and said millimeter wave band oscillator which was not modulated with this pulse modulator, and receives the reflected wave from a detection body, and a mixer which carries out the mixer of the signal by which pulse modulation was carried out to the input signal with the pulse modulator.
[Claim 6] The millimeter wave radar characterized by consisting of a millimeter wave band oscillator, the modulator which carries out pulse modulation of the oscillation signal from this millimeter wave band oscillator, the band-pass filter which passes the oscillation signal frequency of said millimeter wave band oscillator, and does not pass the signal frequency by which pulse modulation was carried out, an antenna which transmit and receive the signal which passed this band-pass filter, and a mixer which carries out the mixer of the signal which does not pass said filter, and the input signal.
[Claim 7] A millimeter wave band oscillator and the 1st NRD guide which leads the output of this millimeter wave band oscillator to the 1st circulator, The pulse modulator connected to this 1st circulator, and the 2nd NRD guide which connects said the 1st circulator and 2nd circulator, the 3rd NRD guide connected to the 2nd circulator -- this -- the millimeter wave radar characterized by consisting of a transceiver antenna connected to the 3rd NRD guide, and a mixer connected to said 2nd circulator.
[Claim 8] Said pulse modulator is a millimeter wave radar according to claim 5 to 7 characterized by having a modulation port between an input edge port and an outgoing end port, consisting of a circulator which connected high-speed operation components, such as a 2 terminal

semiconductor device like a schottky-barrier diode, or FET (field effect transistor), a 3 terminal semiconductor device like HEMT (high electron mobility transistor), to the modulation port, impressing a millimeter wave signal to an input edge port, and impressing a pulse to said high-speed operation component.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the millimeter wave radar which enables detection from short distance to a long distance.
[0002]
[Description of the Prior Art] As a method of millimeter wave radars mounted in addition used, such as a passenger car, a bus, and a truck, FM-CW, the 2 cycle CW, a pulse, a pulse doppler, spectrum diffusion, etc. are proposed variously, and development aiming at the about [300m] maximum detection distance is made. On the other hand, the importance of the short-distance detection of several 10cm - about several cm at the time of back start or left turn is also pointed out.
[0003] For example, JP,10-22846,A prepared the dielectric pattern for RF chokes, connected Gunn diode to the above-mentioned dielectric wire way, and has connected varactor diode between the dielectric wire way and the above-mentioned dielectric pattern for RF chokes while it prepares a dielectric wire way in the direction which intersects perpendicularly with the dielectric strip 81, as shown in drawing 17 . And by impressing bias voltage to Gunn diode and impressing a modulating signal to varactor diode from a terminal 83 from the bias terminal 82, the electrostatic capacity of varactor diode is changed and the oscillation frequency of Gunn diode is changed. FM-CW is used in this patent application. An oscillation output is transmitted from the transmitting antenna 86 through a circulator 84 and the dielectric resonator 85 for transmission. It is received by the receiving antenna 87 and the electric wave reflected by the detection body obtains an IF signal for a terminal 89 with a mixer 88.
[0004]
[Problem(s) to be Solved by the Invention] Although most FM-CW methods are used as an electric-wave type radar, a FM-CW method is difficult for high precision body detection of several m or less because of a noise, and since the oscillation frequency of an oscillator is changed in time, the problem is also left behind to detection range accuracy from the point of frequency stability. Although its detection range accuracy is good since a pulse method can stabilize an oscillation frequency, it is necessary to use a millimeter wave, in order to perform short-distance detection of several cm order, and to modulate a millimeter wave signal by the trigger pulse of order several ns. In order to modulate a millimeter wave with the pulse width of order several ns using a semiconductor device, the PIN diode regularly used by the current pulse radar will be used, but the minority carrier lifetime of a PIN diode is several 10ns order, and since it is long, it is difficult the lifetime to treat the high-speed pulse of order several ns.
[0005] Although there is also a short-distance radar using a light wave or a supersonic wave, light waves are storm sewage, dew, fog, etc., and a supersonic wave has the problem which causes malfunction by atmospheric temperature, a wind, etc., respectively.
[0006] The millimeter wave radar which can detect the several 10cm - about several cm short distance made conventionally difficult with high precision is offered this invention solving the above-mentioned problem, and operating to stability also under SIGMET, and holding about [300m] maximum distance.

[0007]
[Means for Solving the Problem] the millimeter wave radar of this invention according to claim 1 -- the 1st millimeter wave band oscillator -- this -- it is characterized by detecting the distance to said detection body with the signal received with the transmitting antenna which transmits the oscillation output of the pulse modulator which carries out pulse modulation of the oscillation signal from the 1st millimeter wave band oscillator, and said 1st millimeter wave band oscillator, the receiving antenna which receives the reflected wave from a detection body, and this receiving antenna.
[0008] This description can perform body detection from a several cm short distance to the long distance of several 100m without a noise with high precision. Moreover, since this invention is a method which transmits the oscillation output of the 1st millimeter wave band oscillator directly, it can enlarge a transmitting output compared with the case where the signal which carried out the rise convert is used for a transmission wave. That is, since there is an insertion loss and the transmitting output became small when the output which carried out the rise convert was used for a transmission wave, and carrying out a rise convert, in order to compensate this, the power amplifier of a transmission wave had to be used. However, the high-speed operation component of a pulse modulator solved the problem by using for the transmission wave of a radar the reflected wave of high power generated at the time of mismatching, and, moreover, this invention has realized high-performance-izing of a radar, and low cost.
[0009] The millimeter wave radar of this invention according to claim 2 is characterized by said pulse modulator being constituted by high-speed operation components, such as a 2 terminal semiconductor device like a schottky-barrier diode, or FET (field effect transistor), a 3 terminal semiconductor device like HEMT (high electron mobility transistor).
[0010] According to this description, since a minority carrier lifetime is constituted by high-speed operation components, such as a 2 terminal semiconductor device like a short schottky-barrier diode, or FET (field effect transistor), a 3 terminal semiconductor device like HEMT (high electron mobility transistor), like number ps order, high-speed switching operation is performed and a pulse modulator can obtain a millimeter wave pulse radar.
[0011] The millimeter wave radar of this invention according to claim 3 carries out the mixer of said input signal and the oscillation signal of the 2nd millimeter wave band oscillator with a mixer, and is characterized by measuring the time difference of a transmission wave pulse and a received wave pulse, and measuring the distance from this time difference to a detection body from the output of this mixer.
[0012] According to this description, as for this invention, the shortest detection distance can detect [the longest detection distance] even one half of pulse width from 1/2 of a pulse period.

[0013] The millimeter wave radar of this invention according to claim 4 is characterized by said 1st millimeter wave band oscillator, a pulse modulator, a transmitting antenna, a receiving antenna, the 2nd millimeter wave band oscillator, and a mixer being connected by the NRD guide.

[0014] According to this description, the millimeter wave radar of this invention can be constituted from low loss in a compact, and operational stability of a millimeter wave is obtained.

[0015] The millimeter wave radar of this invention according to claim 5 transmits the oscillation output of a millimeter wave band oscillator, the frequency-conversion pulse modulator which carries out pulse modulation of the output of this millimeter wave band oscillator, and said millimeter wave band oscillator which was not modulated with this pulse modulator, and is characterized by consisting of a transceiver antenna which receives the reflected wave from a detection body, and a mixer which carries out the mixer of the signal by which pulse modulation was carried out to the input signal with the pulse modulator.
[0016] This description can perform body detection from a several cm short distance to the long distance of several 100m without a noise with high precision. Moreover, since this invention is a method which transmits the oscillation output of a millimeter wave band oscillator directly, it can enlarge a transmitting output compared with the case where the signal which carried out the rise

convert is used for a transmission wave. That is, since there is an insertion loss and the transmitting output became small when the output which carried out the rise convert was used for a transmission wave, and carrying out a rise convert, in order to compensate this, the power amplifier of a transmission wave had to be used. However, the high-speed operation component of a pulse modulator solved the problem by using for the transmission wave of a radar the reflected wave of high power generated at the time of mismatching, and, moreover, this invention has realized high-performance-izing of a radar, and low cost. Furthermore, one millimeter wave oscillator can be used for the object for transmission, and reception, and can be manufactured cheaply.
[0017] It is characterized by the millimeter wave radar of this invention according to claim 6 consisting of a millimeter wave band oscillator, the modulator which carries out pulse modulation of the oscillation signal from this millimeter wave band oscillator, the band-pass filter which passes the oscillation signal frequency of said millimeter wave band oscillator, and does not pass the signal frequency by which pulse modulation was carried out, an antenna which transmit and receive the signal which passed this band-pass filter, and a mixer which carries out the mixer of the signal which does not pass said band-pass filter, and the input signal.
[0018] According to this description, frequency conversion of the oscillation signal of a millimeter wave band oscillator can be carried out, it can discriminate from the signal sent to a sending signal and a mixer with a band-pass filter, and can use the output of one millimeter wave oscillator for the object for transmission, and the local oscillation of a receiver.
[0019] The 1st NRD guide whose millimeter wave radar of this invention according to claim 7 leads the output of a millimeter wave band oscillator and this millimeter wave band oscillator to the 1st circulator, The frequency-conversion pulse modulator connected to this 1st circulator, and the 2nd NRD guide which connects said the 1st circulator and 2nd circulator, the 3rd NRD guide connected to the 2nd circulator -- this -- it is characterized by consisting of a transceiver antenna connected to the 3rd NRD guide, and a mixer connected to said 2nd circulator.
[0020] According to this description, one millimeter wave oscillator can be used for the object for transmission, and reception, and can be manufactured cheaply. Moreover, it can constitute from low loss in a compact, and operational stability of a millimeter wave is obtained.
[0021] It is characterized by for said pulse modulator having a modulation port between an input edge port and an outgoing end port, and for the millimeter wave radar of this invention according to claim 8 consisting of a circulator which connected high-speed operation components, such as a 2 terminal semiconductor device like a schottky-barrier diode, or FET (field effect transistor), a 3 terminal semiconductor device like HEMT (high electron mobility transistor), to the modulation port, impressing a millimeter wave band signal to an input edge port, and impressing a pulse to said high-speed operation component.
[0022] Pulse modulation is performed to coincidence with the rise convert of a millimeter wave signal by this description.
[0023]
[Embodiment of the Invention] (Example 1) The circuit diagram of an example 1 is shown in drawing 1 . The millimeter wave radar of drawing 1 consists of the millimeter wave band oscillator 1, a pulse modulator 2, a circulator 3, the transmitting antenna 5, a receiving antenna 6, a mixer 7, a local oscillator 8, the IF amplifier 9, a variable gain amplifier (AGC) 10, a wave detector 11, and a baseband (BB) amplifier 12. It connects using a NRD guide (nonradioactive dielectric wire way), and these millimeter wave band oscillator 1, a pulse modulator 2, a circulator 3, the transmitting antenna 5, a receiving antenna 6, a mixer 7, and a local oscillator 8 consist of millimeter wave circuits. The directional coupler 13 which leads a part of sending signal to a mixer 7 is formed near the transmitting antenna 5 and a receiving antenna 6.
[0024] The millimeter wave band oscillator 1 consists of the frequency stabilization Gunn oscillators using Gunn diode, and acquires a 60GHz band and 77GHz band oscillation signalling frequency. A pulse modulator 2 consists of ASK modulators using a schottky-barrier diode (SBD), as shown in drawing 2 and drawing 3 . in drawing 2 , a pulse modulator 2 is constituted using a NRD guide -- having -- a NRD guide -- the upper -- a conductor -- a plate 101 and the

bottom -- a conductor -- between plates 102, a dielectric strip is arranged, it is constituted, and a single mode actuation band is obtained. The oscillation output of the millimeter wave band oscillator 1 is applied to the 1st NRD guide 103, and an oscillation output signal goes in the direction of a circulator 104. The NRD guide 105 which faces to a pulse modulator 2, and the NRD guide 106 which outputs a modulation output signal are connected to a circulator 103. The NRD guide 105 is connected to a pulse modulator 2 through an air gap 107.

[0025] As shown in drawing 3 , a pulse modulator 2 etches copper foil into the Teflon substrate 108, forms the bias choke 109 and a low-pass filter 110, between this bias choke 109 and a low-pass filter 110, connects schottky diode 111 and is constituted. As an example, width of face is 2.25mm, die length repeats [the thick pattern part which is 1.0mm, and width of face] three steps of thin pattern parts whose die length is 1.1mm in 0.2mm by 2.0mm, and, as for the Teflon substrate 108, width of face is formed here, as for a bias choke. As for a low-pass filter 110, width of face consists of a thick part whose die length is 1.0mm, and a thin part whose die length is 1.1mm by width of face of 0.2mm by 2.0mm. And a 0.4mm clearance is opened between the bias choke 109 and a low-pass filter 110, the electrodes 112 and 113 whose width of face is two whose die length is 1.0mm in 1.4mm are formed, and a schottky-barrier diode 111 is connected between these two electrodes 112 and 113. This pulse modulator 2 attached the piece 114 of Teflon in the rear face of mounting of a schottky-barrier diode 111, and it has protected it so that a schottky-barrier diode 111 may not break. Moreover, the high dielectric constant thin film 115 was attached in the front-face side (millimeter wave incidence side) of mounting of a schottky-barrier diode 111, and resistance has taken adjustment with a small schottky-barrier diode and the NRD guide 105 with a high impedance. The thickness of a high dielectric constant thin film is Abbreviation lambda / 4. Furthermore, before and after the high dielectric constant thin film, the piece 116 of Teflon is attached and adjustment with a NRD guide is raised more.

[0026] the bias choke 109 of a pulse modulator 2 -- wiring 117 -- the bottom -- a conductor -- pass the hole 118 of a plate 102 -- it connects with the digital signal terminal 121 through the direct-current load resistance 119 and the direct-current load resistance 120. Incidentally 10 ohms and the direct-current load resistance 120 were set as 50 ohms for the direct-current load resistance 119 as an example. moreover, the low-pass filter 110 -- wiring 122 -- the bottom -- a conductor -- pass the hole 123 of a plate 102 -- it connects with a ground.

[0027] Therefore, if the millimeter wave band oscillator 1 oscillates 60GHz and the negative polarity trigger pulse whose pulse width is 5ns and 1 microsecond of pulse repetition periods is impressed to the digital signal terminal 121 of a pulse modulator 2 as bias voltage, the oscillation signal of the millimeter wave band oscillator 1 will be absorbed by the direct-current load resistance 119 and 120 by which it operated as a wave detector since the forward direction period was turned on, and bias voltage connected the schottky-barrier diode 111 to the schottky-barrier diode. The direct-current load resistance 119 and 120 is set up here so that adjustment of order and the reverse bias impression schottky diode 111, and a pulse wave can be taken. On the other hand, the oscillation signalling frequency of the millimeter wave band oscillator 1 with which bias voltage carried out incidence of the hard flow period to the pulse modulator 2 when it did not operate as a wave detector, since schottky diode 111 would be in an OFF state serves as mismatching, and is reflected. ASK pulse modulation is performed by the above actuation.

[0028] Moreover, a pulse modulator 2 can be constituted like drawing 4 using high-speed operation components, such as 3 terminal semiconductor devices, such as FET and HEMT. As shown in drawing 4 , the modulation port 53 is arranged for the circuit diagram of this pulse modulator 2 between the input port 51 and the output ports 52 of a circulator 3, and the source drain terminal of 3 terminal semiconductor device 54 is connected to the modulation port 53. The adjustment load resistance 56 is connected with the source between grounds, a pulse signal is impressed to the gate as bias voltage from a terminal 58 through the RF choke 57, and to a drain, through the choke 59 for noise rejection, a millimeter wave band signal is impressed and is operated from a terminal 60. Therefore, when the pulse signal impressed to the gate is high-level, between the drain sources of 3 terminal semiconductor device connects too hastily, and the millimeter wave signal inputted into the drain is absorbed by the adjustment load resistance

56. Since it is opened between the drain sources when a pulse signal is a low level, the millimeter wave signal inputted into the drain is reflected, and, as a result, a modulating signal-ed [pulse] is acquired in the output port 52 of a circulator 3.
[0029] Drawing 5 shows the example which applied the circuit shown in drawing 4 to the microstrip, and attaches and shows suffix a to drawing 4 and an equivalent part. In addition, 61 shows the capacitor for DC blocking and 62 shows a matching circuit. Actuation of an up converter is performed in the circuit of drawing 5 as well as the circuit of drawing 4 . Moreover, drawing 6 shows the example applied to the NRD guide, and attaches and shows suffix b to drawing 4 and an equivalent part.
[0030] As mentioned above, while the millimeter wave band signal reflected with the pulse modulator 2 passes a circulator 3 and is transmitted from the transmitting antenna 5, the part is led to a mixer 7 by the directional coupler 13 as a criteria wave.
[0031] It is received by the receiving antenna 6 and the reflected wave reflected by the detection body is inputted into a mixer 7. A part of criteria wave supplied by the directional coupler 13 is inputted into a mixer 7 as an input signal and the local oscillation signal from a local oscillator 8, and when a mixer 7 operates as a down converter, an intermediate frequency signal is outputted. Here, it is constituted from the frequency stabilization Gunn oscillator by Gunn diode like the millimeter wave band oscillator 1, and a mixer 7 consists of balance mold mixers, and the local oscillator 8 is performing heterodyne reception. An intermediate frequency signal acquires the criteria wave pulse P1 and the reflected wave pulse P2 to an output terminal 15 through the IF amplifier 9, a variable gain amplifier (AGC) 10, a wave detector 11, and the baseband (BB) amplifier 12 further.
[0032] As shown in drawing 7 , distance [to a detection body] R (m) is computable from (1) type by measuring time difference delta[of the criteria wave pulse P1 and the received wave pulse P2] t (s).
[0033]
R=delta t.c/2 (1)
Here, c is the velocity of light (m/s).
The maximum detection distance (Rmax) of this millimeter wave radar is found by (2) formulas from the pulse repetition period (tp) impressed to a pulse modulator 2.
[0034]
Rmax=tp-c/2 (2)
Moreover, the minimum detection distance (Rmin) is found by (3) formulas from the pulse width (tw) impressed to a pulse modulator 2.
[0035]
Rmin=tw-c/2 (3)
2 terminal semiconductor device [like a schottky-barrier diode] whose pulse modulator 2 of this invention is, Or since it is made to operate with an external modulation method using high-speed operation components, such as FET (field effect transistor) and a 3 terminal semiconductor device like HEMT (high electron mobility transistor), and is constituted by the NRD guide ASK modulator Since the minority carrier lifetime is very as short as number ps order and it has the high-speed engine performance which high-speed switching operation is performed and is still generous enough to transmission-speed 400Mbps, the minimum detection distance of several cm can be acquired.
[0036] Moreover, since the millimeter wave band oscillator 1 of this invention is constituted by the frequency stabilization Gunn oscillator and a pulse modulator 2 is constituted by the ASK modulator, there are few frequency drifts, detection distance is **2cm or less ranging from several cm to several 10m, and a measurement error can detect the distance to a detection body with high precision, as shown in drawing 8 (an axis of abscissa is detection distance and an axis of ordinate is an error).
[0037] Moreover, since this invention is a method which transmits the oscillation output of a millimeter wave band oscillator directly, it can enlarge a transmitting output compared with the case where the signal which carried out the rise convert is used for a criteria wave. That is, since there is an insertion loss and the transmitting output became small when the output which

carried out the rise convert was used for a transmission wave, and carrying out a rise convert, in order to compensate this, the power amplifier of a transmission wave had to be used. However, this invention controlled in time the bias voltage impressed to the high-speed operation component which constitutes a pulse modulator, the problem was solved by using the reflected wave of high power at the time of the mismatching of a high-speed operation component for the criteria wave of a radar, and, moreover, high-performance-izing of a radar and low cost are realized.
(Example 2) In the example 2 of this invention, a millimeter wave radar consists of an oscillator 21, the 1st circulator 22, the 2nd circulator 23, the frequency conversion pulse modulator 24, a mixer (down converter) 25, a band-pass filter 26, and an antenna 27, as shown in drawing 9 .
[0038] An oscillator 21 is constituted using Gunn diode, a millimeter wave band signal is oscillated, and this oscillation signal is supplied to the frequency-conversion pulse modulator 24 through the 1st circulator 22. The frequency conversion pulse modulator 24 is constituted by the schottky-barrier diode (SBD), as shown in drawing 10 (a), it impresses the non-become irregular continuous wave signal CW to a schottky-barrier diode as an intermediate frequency signal PIF, and as shown in drawing 10 (b), it impresses pulse width tw and the negative polarity trigger pulse of a pulse repetition period tp as bias voltage VB. As for the schottky-barrier diode, the millimeter wave matching circuit is set up so that bias voltage may operate as a frequency converter in a forward direction period. Therefore, if the intermediate frequency signal PIF and the forward-bias electrical potential difference VB are impressed to the coincidence by which the oscillation signal of an oscillator 21 is impressed to the frequency-conversion pulse modulator 24 through the 1st circulator 22, in the frequency-conversion pulse modulator 24, it will operate as a frequency-conversion pulse modulator, and millimeter wave band signalling frequency will be changed into the sum of the frequency (fRF) and intermediate frequency (fIF), and the frequency (fRF**fIF) component of a difference. This frequency component signal is led to a band-pass filter 26 after passing the 1st circulator 22 and 2nd circulator 23. Since the center frequency of a band-pass filter 26 is set as the frequency of the millimeter wave band signal of an oscillator 21, the signal of the frequency (fRF**fIF) of the sum and a difference is reflected with a band-pass filter 26. The frequency (fRF**fIF) component signal of the sum and the difference which were reflected is added as a local oscillation signal of a mixer 25 through the 2nd circulator 23.
[0039] On the other hand, if hard flow bias voltage is impressed to a schottky-barrier diode, since the frequency conversion pulse modulator 24 does not operate as an up converter, it will be reflected in this part for mismatching, and the millimeter wave band signalling frequency impressed to the schottky-barrier diode will be led to a band-pass filter 26 after passing the 1st circulator 22 and 2nd circulator 23. Since the center frequency of a band-pass filter 26 is set as the frequency of the millimeter wave band signal of an oscillator 21, the millimeter wave band signalling frequency led to the band-pass filter 26 passes a band-pass filter 26, and as shown in drawing 10 (c) from an antenna 27, it is discharged as a sending signal PT of a radar. And the reception output PR with which heterodyne detection of the reflected wave from a detection body is carried out to the signalling frequency of said sum and a difference, and the down converter of the balance mixer mold constituted by the schottky-barrier diode indicates it to be to drawing 10 (d) as a result is obtained. Distance [from a radar to a detection body] R (m) is expressed by said formula (1) when time amount delta[of the difference by the time of day when the reflected wave came from the time of day which discharged the transmission wave] t, and the velocity of light are set to c (m/s) (s). Moreover, the maximum detection distance Rmax of a millimeter wave radar can be found from said formula (2) from the repeat period tp of a pulse, and the minimum detection distance can calculate Rmin by said formula (3) from pulse width tw.
[0040] Moreover, since this invention is a method which transmits the oscillation output of a millimeter wave band oscillator directly, it can enlarge a transmitting output compared with the case where the signal which carried out the rise convert is used for a criteria wave. That is, since there is an insertion loss and the transmitting output became small when the output which carried out the rise convert was used for a transmission wave, and carrying out a rise convert, in order to compensate this, the power amplifier of a transmission wave had to be used. However,

this invention controlled in time the bias voltage impressed to the high-speed operation component which constitutes a pulse modulator, the problem was solved by using the reflected wave of high power at the time of the mismatching of a high-speed operation component for the criteria wave of a radar, and, moreover, high-performance-izing of a radar and low cost are realized.

[0041] The millimeter wave radar of the example 2 of this invention is constituted as shown in the top view of drawing 11 , and the pictorial drawing of drawing 12 using a NRD guide (nonradioactive dielectric wire way). A NRD guide is used as the transmission line of a millimeter wave band like a 35GHz band and a 60GHz band, inserts a rectangular dielectric strip into a cutoff parallel monotonous waveguide, and is constituted. about 4.0mm in thickness it is thin from a right conductor and non-magnetic-material ingredients, such as aluminum by which set predetermined spacing up and down and parallel arrangement was carried out as a NRD guide was shown in drawing 13 , copper, and brass, -- the upper -- a conductor -- a plate 31 and the bottom -- a conductor -- the dielectric strip 33 of the shape of height a and a square bar of width of face b is arranged between plates 32, and it is constituted between. When dielectrics, such as 3.0 or less, for example, the Teflon of 2.04, polyethylene of 2.1, and polystyrene of 2.56, are used by high frequency like a millimeter wave band as a dielectric strip 33 and low loss specific inductive capacity sets free space wave length of signal frequency to lambda 0, for the width of face b near a= 0.45lambda0, height a of the dielectric strip 33 is [0042] when specific inductive capacity is set to epsilonr.

[Equation 1]

$$b=\frac{0.51}{\sqrt{\varepsilon_r-1}}\lambda_0$$

[0043] It is alike and is set up. With the 60GHz band, when Teflon is used as a dielectric strip, it was set as height of a= 2.25mm, and width of face of b= 2.5mm, and the single mode actuation band has been obtained from 55GHz by 65.5GHz.

[0044] The millimeter wave radar of this invention is constituted as the transmission line using the above-mentioned NRD guide. As the pictorial drawing from [of the parts of drawing 11 and the Gunn diode oscillator 21 of drawing 12] another is shown in drawing 14 (a) and the fragmentary sectional view of a Gunn diode oscillator is shown in drawing 14 (b), the Gunn diode oscillator 21 Gunn diode 41 is enclosed into a cylindrical porcelain package, has H form cross-section configuration, and mounts it on the side face of the piece 42 of a metal made from brass which gave lambda / 4 step low-pass filter -- having -- the upper -- a conductor -- a plate 31 and the bottom -- a conductor -- it is sideways loaded between plates 32.

[0045] The Teflon substrate 43 which is the thickness of 0.13mm by which the microstrip low-pass filter track 44 which consists of lambda / four choke patterns by etching as shown in drawing 14 (c) was formed on the 1 front face of the above-mentioned piece 42 of a metal is stuck, bias voltage is impressed to Gunn diode 41 through the microstrip low-pass filter track 44, and a 59GHz band oscillation signal is acquired from the Gunn diode oscillator 21. This oscillation signal is led to the Teflon substrate 45 shown in drawing 14 (d) through the metal strip resonator 47 in which the metal strip 46 was formed at NRD guide 28a. The metal strip resonator 47 can determine an oscillation frequency by the width of face c of the metal strip 46, die-length d, and thickness e of a Teflon substrate. When width of face c of 0.265mm and a metal strip is set to 1.4mm for thickness e of a Teflon substrate as an example and die-length d is changed from 1.5mm to 2.5mm, Adjustable can be carried out to 63GHz from 55GHz, the band of a 60GHz band NRD guide is covered mostly, and the oscillation output of 60mW or more is obtained. In order to stop the unnecessary mode produced in a part for a bond part here in the point to which the NRD guide 28 touches the metal strip resonator 47, it is desirable to insert the mode suppressor 29. The metal strip resonator 46 changes the die length of a metal strip, and is adjusted to the target frequency band of 59GHz. In this example, it was adjusted to 58.36GHz or 59.15GHz.

[0046] said near NRD guide 28a -- a frequency stabilization sake -- high -- it arranges so that the ceramic resonator 48 which has Q may join together a side -- having -- the ceramic resonator 48 -- the upper and lower sides -- a conductor -- frequency stabilization is attained

by operating considering the direction of plate spacing as cavity length. the ceramic resonator 48 -- high -- ceramic disk 48a of Q is made into middle, and it constitutes from Teflon disks 48b and 48c on both sides of the upper and lower sides -- having -- ceramic disk 48a -- the upper and lower sides -- a conductor -- it is made for radiation to be lost as it comes to the center position of a plate Resonance frequency was set to 59GHz, when ceramic disk 48a shortened cavity length by making thickness t thin, and could make resonance frequency high and thickness was set to 0.47mm.

[0047] As shown in drawing 11 , this ceramic resonator 48 set the distance g from NRD guide 28a as 1.35mm, and set the standing-wave ratio to 2. Moreover, the distance z from the mode SAPURESA end face of the NRD guide 28 to the core of the ceramic resonator 48 was set as the location as for which the ceramic resonator 48 carries out a locking. Locking locations were 6.0mm and 6.5mm. At the time of a locking, fluctuation of an oscillation frequency was not observed as for 50kHz in the frequency shaft (SPAN) of a spectrum analyzer, but the wave was also beautiful.

[0048] An alumina etc. can be used for the ceramic resonator 48 as an alternative of a ceramic disk, and polyethylene, polystyrene, boron nitride, etc. can be used for it as an alternative of a Teflon disk. Although a configuration can be made an ellipse form, a triangle, and a rectangle in addition to circular, it is the easiest to manufacture a round shape. furthermore, the ceramic resonator 48 -- a ceramic disk -- the upper and lower sides -- a conductor -- the configuration which considers as the structure which supports either a top or the bottom by the Teflon disk so that it may become the middle of a plate, and makes another side space may be used. In this case, a ceramic disk has a good way with the dielectric constant near infinity.

[0049] the Teflon disks 48b and 48c which the ceramic resonator 48 makes middle ceramic disk 48a which has Quantity Q as said explanation, and which is a comparatively hard dielectric, and are dielectrics with it about the upper and lower sides -- inserting -- making -- ceramic disk 48a -- the upper and lower sides -- a conductor -- it is constituted so that it may be located at the core of a plate. [a low dielectric constant and] [softer than a ceramic] As for the ceramic resonator 48, it is desirable for it to be formed circularly and to cover the perimeter with the Teflon tube (not shown) by which a ring-like dielectric constant consists of a low dielectric. A Teflon tube prevents the effect of the humidity by dew condensation etc. inside a NRD guide transmitter and a NRD guide receiver at the same time it prevents form collapse of the ceramic resonator 48. the resonance frequency of the ceramic resonator 48 -- that thickness t -- including -- the upper and lower sides -- a conductor -- the upper and lower sides which make the direction of plate spacing cavity length -- a conductor -- it is determined at intervals of a plate and resonates on the frequency from which this spacing becomes the integral multiple of the half-wave length electrically. Since this ceramic resonator 48 resonates by TE (02delta), it can make ceramic disk 48a thin, and can make resonance frequency high. the height of the whole ceramic resonator 48 -- the upper and lower sides -- a conductor -- adjusting to spacing of 2.25mm of a plate, it is thin in ceramic disk 48a, and the Teflon disks 48b and 48c are thickened, and resonance frequency is adjusted. Thickness of ceramic disk 48a is set to 0.47mm, and the resonance frequency of a 59GHz band is obtained.

[0050] The oscillation signal inputted into NRD guide 28a is drawn in the direction of the frequency-conversion pulse modulator 24 by the 1st circulator 22, and is inputted through NRD guide 28b. Although the frequency-conversion pulse modulator 24 is constituted as shown in drawing 15 , and constituted almost like the pulse modulator of drawing 2 and drawing 3 explained in the example 1, difference is in the signal impressed to a bias choke. That is, as shown in drawing 13 , the continuous wave of drawing 10 (a) non-become irregular is impressed to IF impression terminal 130, and the trigger pulse of drawing 10 (b) is impressed to the bias terminal 131.

[0051] Moreover, as this frequency conversion pulse modulator is shown in drawing 16 R> 6, it is constituted using FET (field effect transistor) or a 3 terminal semiconductor device 140 like HEMT (high electron mobility transistor), the modulation port 53 is arranged between the input edge port 51 of the 1st circulator 22, and the outgoing end port 52, and the frequency conversion pulse modulator 24 is connected to the modulation port 53. The circuit diagram of

the frequency-conversion pulse modulator 24 which consists of a 3 terminal semiconductor device 140 connects the gate source terminal of 3 terminal semiconductor device 140 to the modulation edge port 53 of the 1st circulator 22, as shown in drawing 1616 . A millimeter wave band signal is impressed to the gate, and the non-become irregular continuous wave signal of drawing 10 (a) is impressed to a drain as an intermediate frequency signal from a terminal 142. Moreover, the pulse of drawing 10 (b) is impressed to a drain as bias voltage from a terminal 141. In the frequency-conversion pulse modulator 24 of this configuration, when a millimeter wave band oscillation signal is impressed to the input edge port 51, the pulse was impressed to the terminal 141 and GaAsFET is used as a 3 terminal semiconductor device 140, as for the carrier wave which between the drain sources inputted into 3 terminal semiconductor device 140 by 3 terminal semiconductor device 140 serving as high resistance, a pulse signal is outputted to the outgoing end port 52 in response to reflection on "Low" level (- number V). On the other hand, a pulse signal serves as a nonlinear field between the drain sources on "High" level (+ number V), and the sum of a millimeter wave band oscillation signal and an intermediate frequency signal and the signalling frequency of a difference are acquired in the outgoing end port 52. A frequency-conversion pulse modulator is constituted based on the above actuation.

[0052] As described above, the sum signal and difference signal by which frequency conversion was carried out face to a band-pass filter 26 through the 2nd circulator 23 and NRD guides 28c and 28d with the frequency-conversion pulse modulator 24. A band-pass filter 26 consists of the three-step Chebyshev filters of the center frequency of 60.625GHz, the bandwidth of 2GHz, and 0.5dB ripple, only millimeter wave band oscillation signalling frequency is passed, it is transmitted to the transmitting antenna 27, and a millimeter wave electric wave is transmitted from the transmitting antenna 27. It is reflected with a band-pass filter 26, and the sum signal and difference signal of the frequency-conversion pulse modulator 24 are inputted into a mixer 25 through the 2nd circulator 23.

[0053] It is received by the antenna and the electric wave reflected by the detection body is inputted into a mixer 25 through the 2nd circulator 23 and NRD guide 28e. As shown in drawing 12 , a mixer 25 is structure detected with a schottky-barrier diode 61, it attached the piece 62 of Teflon in the rear face of mounting of a schottky-barrier diode 61, and it has protected it so that a schottky-barrier diode 61 may not break. Moreover, the high dielectric constant thin film was attached in the front face (millimeter wave band signal incidence side) of mounting of a schottky-barrier diode 61, and resistance has taken adjustment with a small schottky-barrier diode and the NRD guide 28 with a high impedance. The thickness of a high dielectric constant thin film is Abbreviation lambda / 4. Furthermore, after the high dielectric constant thin film, the Teflon chip 63 is attached and adjustment with a NRD guide is raised more.

[0054] By carrying out the mixer of said sum signal and reflected wave with a mixer 25, a down convert is carried out and a millimeter wave band signal obtains the original IF signal for a terminal 64. After this, although not illustrated, it has the IF amplifier 9, a variable gain amplifier (AGC) 10, a wave detector 11, and the baseband (BB) amplifier 12 like an example 1, and a criteria wave pulse and a received wave pulse are acquired from an output terminal 15. And the distance to a detection body is detected.

[0055] Since this invention is a method which transmits the oscillation output of a millimeter wave oscillator directly, it can enlarge a transmitting output compared with the case where the signal which carried out the rise convert is used for a transmission wave. That is, since there is an insertion loss and the transmitting output became small when the output which carried out the rise convert was used for a transmission wave, and carrying out a rise convert, in order to compensate this, the power amplifier of a transmission wave had to be used. However, this invention controlled in time the bias voltage impressed to a frequency conversion pulse modulator, the problem was solved by using for the transmission wave of a radar the reflected wave of high power generated at the time of the mismatching of a frequency conversion pulse modulator, and, moreover, high-performance-izing of a radar and low cost are realized.

[0056]

[Effect of the Invention] According to this invention, body detection from a several cm short distance to the long distance of several 100m can be performed without a noise with high

precision as mentioned above. Moreover, since a pulse modulator is constituted using high-speed operation components, such as a 2 terminal semiconductor device like a short schottky-barrier diode, or FET (field effect transistor), a 3 terminal semiconductor device like HEMT (high electron mobility transistor), like number ps order in a minority carrier lifetime, high-speed switching operation is performed and a millimeter wave pulse radar can be obtained. Furthermore, the millimeter wave radar of this invention can be constituted in a compact, and operational stability of a millimeter wave is obtained. Moreover, as for this invention, the shortest detection distance can detect [the longest detection distance] even one half of pulse width from 1/2 of a pulse period. And according to this invention, one millimeter wave oscillator can be used for the object for transmission, and reception, and can be manufactured cheaply. Moreover, a rise convert can be carried out and pulse modulation of the millimeter wave signal can be carried out.

[Translation done.]

EFFECT OF THE INVENTION

[Effect of the Invention] According to this invention, body detection from a several cm short distance to the long distance of several 100m can be performed without a noise with high precision as mentioned above. Moreover, since a pulse modulator is constituted using high-speed operation components, such as a 2 terminal semiconductor device like a short schottky-barrier diode, or FET (field effect transistor), a 3 terminal semiconductor device like HEMT (high electron mobility transistor), like number ps order in a minority carrier lifetime, high-speed switching operation is performed and a millimeter wave pulse radar can be obtained. Furthermore, the millimeter wave radar of this invention can be constituted in a compact, and operational stability of a millimeter wave is obtained. Moreover, as for this invention, the shortest detection distance can detect [the longest detection distance] even one half of pulse width from 1/2 of a pulse period. And according to this invention, one millimeter wave oscillator can be used for the object for transmission, and reception, and can be manufactured cheaply. Moreover, a rise convert can be carried out and pulse modulation of the millimeter wave signal can be carried out.

[Translation done.]

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] The block diagram of the millimeter wave radar of the example 1 of this invention is shown.
[Drawing 2] The perspective view which applied the millimeter wave radar of an example 1 to the NRD guide is shown.
[Drawing 3] The top view of the frequency-conversion pulse modulator used for an example 1 is shown.
[Drawing 4] The circuit diagram of the pulse modulator used for an example 1 is shown.
[Drawing 5] Drawing which constituted the pulse modulator from microphone loss TORRIPU is shown.
[Drawing 6] Drawing which constituted the pulse modulator from a NRD guide is shown.
[Drawing 7] The wave form chart explaining actuation of an example 1 is shown.
[Drawing 8] It is drawing explaining the measurement error of an example 1.
[Drawing 9] The block diagram of the example 2 of this invention is shown.
[Drawing 10] It is a wave form chart explaining actuation of an example 2.
[Drawing 11] The top view which applied the millimeter wave radar of an example 2 to the NRD guide is shown.
[Drawing 12] The pictorial drawing which applied the millimeter wave radar of an example 2 to the NRD guide is shown.
[Drawing 13] It is drawing explaining a NRD guide.
[Drawing 14] The NRD guide pictorial drawing near a Gunn diode oscillator is shown.
[Drawing 15] The NRD guide pictorial drawing near a frequency-conversion pulse modulator is shown.
[Drawing 16] The circuit diagram of a frequency-conversion pulse modulator is shown.
[Drawing 17] The configuration of the conventional millimeter wave radar is shown.
[Description of Notations]
1 Millimeter Wave Band Oscillator
2 Pulse Modulator
3 Circulator
4 Band-pass Filter
5 Transmitting Antenna
6 Receiving Antenna
7 Mixer
8 Local Oscillator
9 IF Amplifier
10 AGC
11 Wave Detector
12 BB Amplifier
21 Oscillator
22 1st Circulator
23 2nd Circulator

24 Up Converter
25 Mixer
26 Band-pass Filter
27 Antenna

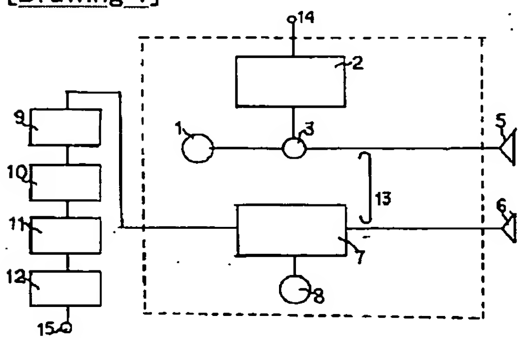
[Translation done.]

* NOTICES *

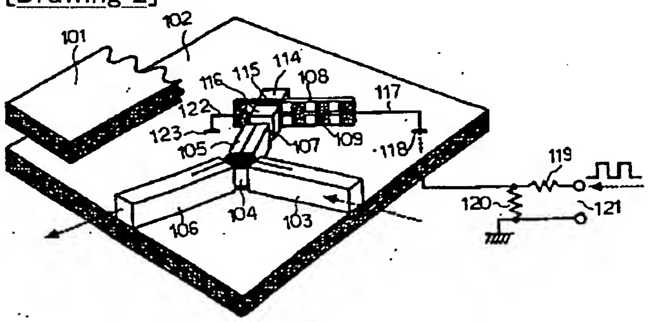
1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DRAWINGS

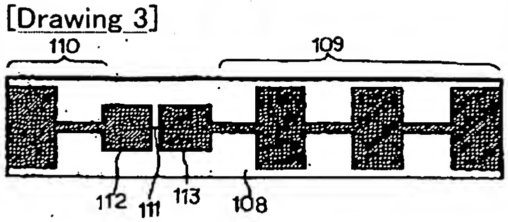
[Drawing 1]



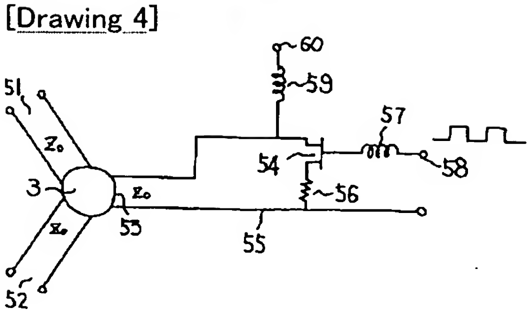
[Drawing 2]



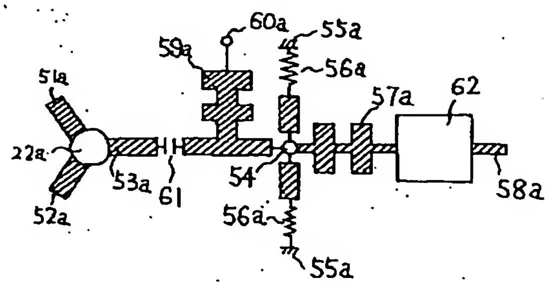
[Drawing 3]



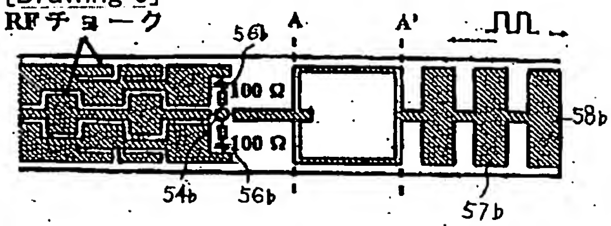
[Drawing 4]



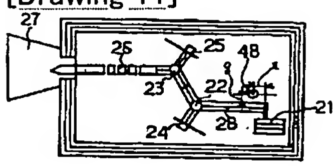
[Drawing 5]



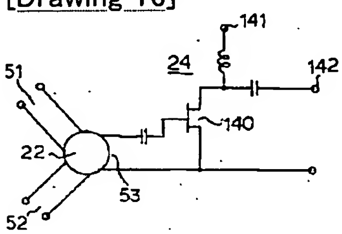
[Drawing 6]



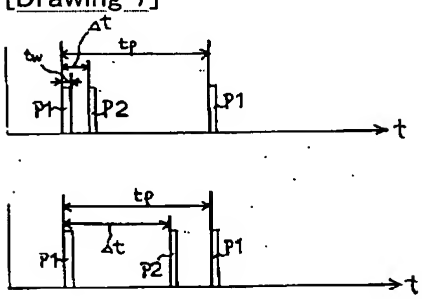
[Drawing 11]



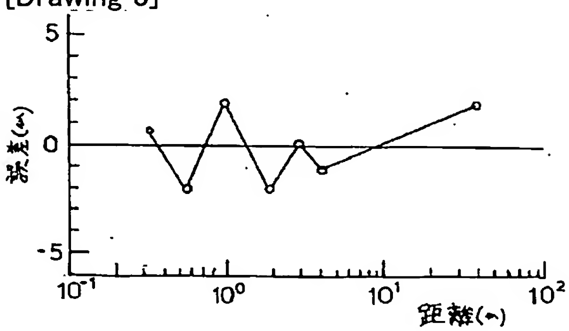
[Drawing 16]



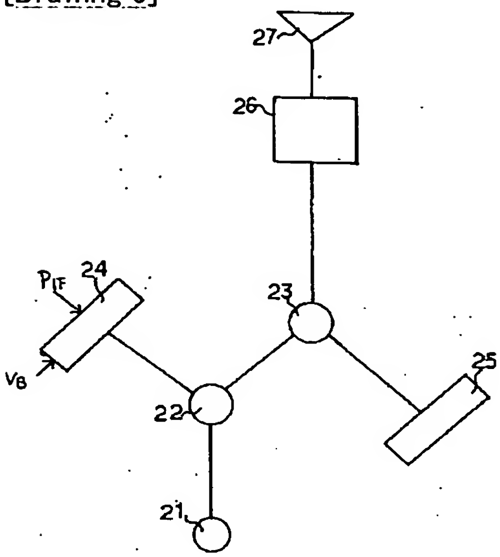
[Drawing 7]



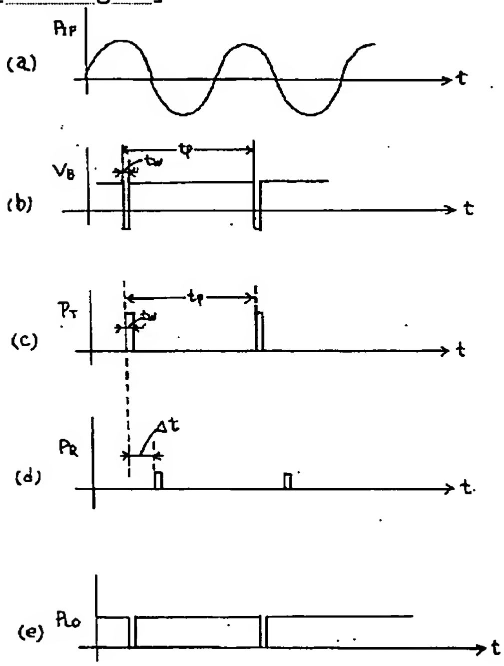
[Drawing 8]



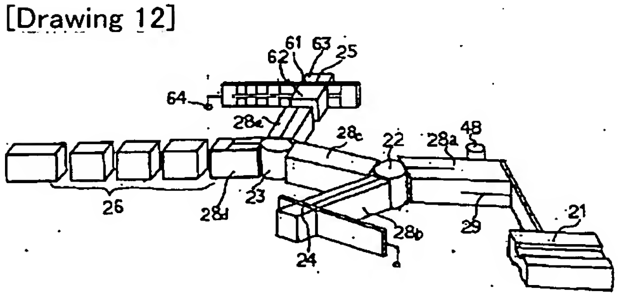
[Drawing 9]



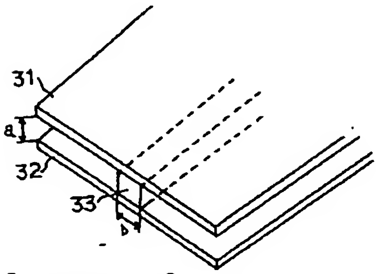
[Drawing 10]



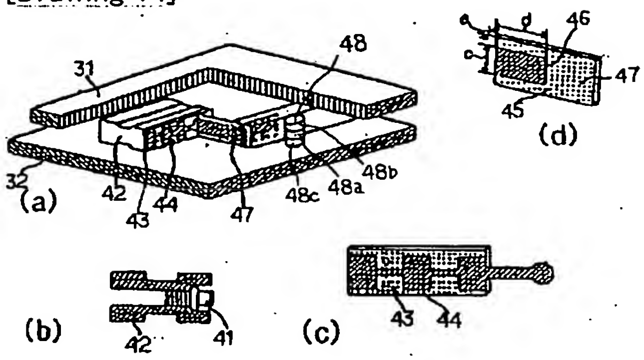
[Drawing 12]



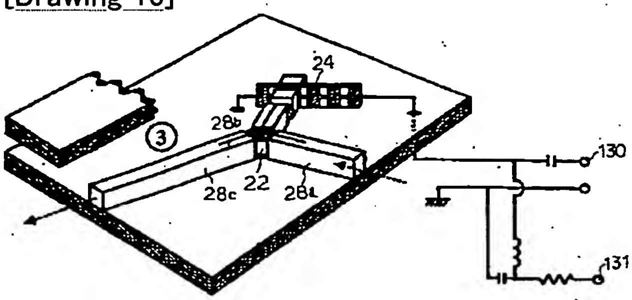
[Drawing 13]



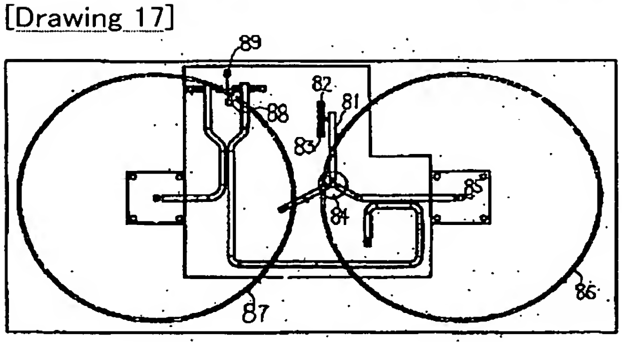
[Drawing 14]



[Drawing 15]



[Drawing 17]



[Translation done.]

CORRECTION OR AMENDMENT

[Kind of official gazette] Printing of amendment by the convention of 2 of Article 17 of Patent Law
[Section partition] The 1st partition of the 6th section
[Publication date] January 23, Heisei 14 (2002. 1.23)

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[Date of Publication] September 22, Heisei 12 (2000. 9.22)
[Annual volume number] Open patent official report 12-2586
[Application number] Japanese Patent Application No. 11-58258
[The 7th edition of International Patent Classification]

G01S 7/03
13/34
H01P 1/387

[FI]

G01S 7/03 C
13/34
H01P 1/387

[Procedure revision]
[Filing Date] July 13, Heisei 13 (2001..7.13)
[Procedure amendment 1]
[Document to be Amended] Specification
[Item(s) to be Amended] Claim
[Method of Amendment] Modification
[Proposed Amendment]
[Claim(s)]
[Claim 1] The millimeter wave radar characterized by having a millimeter wave band oscillator, the pulse modulator which carries out pulse modulation of the oscillation signal from this millimeter wave band oscillator, the transmitting antenna which transmits the millimeter wave band signal reflected with said pulse modulator, and the receiving antenna which receives the reflected wave reflected by the detection body.
[Claim 2] Said pulse modulation means is a millimeter wave radar according to claim 1 characterized by the thing of schottky diode, FET (field effect transistor), or HEMT (high electron mobility transistor) for which it has either at least.
[Claim 3] Said pulse modulator is a millimeter wave radar according to claim 2 characterized by having a circulator and equipping said circulator with a control port between input port, an output port, and said input port and output port.
[Claim 4] Said pulse modulator is a millimeter wave radar according to claim 2 characterized by being a frequency-conversion mold pulse modulator.

[Claim 5] The millimeter wave radar characterized by consisting of a mixer which carries out the mixer of a millimeter wave band oscillator, the pulse modulator which carries out pulse modulation of the oscillation signal from this millimeter wave band oscillator, the transmitting antenna which transmits the millimeter wave band signal reflected with said pulse modulator, the receiving antenna which receives the reflected wave reflected by the detection body, and the signal by which pulse modulation was carried out to the input signal received with this receiving antenna with the pulse modulator.
[Claim 6] The millimeter wave radar according to claim 5 by which a means to transmit the millimeter wave band signal reflected with said pulse modulator to a transmitting antenna, and to transmit the signal by which pulse modulation was carried out with said pulse modulator to a mixer is characterized [which is a band-pass filter].
[Claim 7] The millimeter wave radar characterized by providing the following Millimeter wave band oscillator The 1st NRD guide which leads the output of this millimeter wave band oscillator to the 1st circulator The pulse modulator connected to this 1st circulator the 2nd NRD guide which connects said the 1st circulator and 2nd circulator, and the 3rd NRD guide connected to the 2nd circulator -- this -- the mixer connected with the transceiver antenna connected to the 3rd NRD guide at said 2nd circulator
[Procedure amendment 2]
[Document to be Amended] Specification
[Item(s) to be Amended] 0007
[Method of Amendment] Modification
[Proposed Amendment]
[0007]
[Means for Solving the Problem] The millimeter wave radar of this invention according to claim 1 is characterized by having a millimeter wave band oscillator, the pulse modulator which carries out pulse modulation of the oscillation signal from this millimeter wave band oscillator, the transmitting antenna which transmits the millimeter wave band signal reflected with said pulse modulator, and the receiving antenna which receives the reflected wave reflected by the detection body.
[Procedure amendment 3]
[Document to be Amended] Specification
[Item(s) to be Amended] 0009
[Method of Amendment] Modification
[Proposed Amendment]
[0009] As for the millimeter wave radar of this invention according to claim 2, said pulse modulation means is characterized by the thing of schottky diode, FET (field effect transistor), or HEMT (high electron mobility transistor) for which it has either at least.
[Procedure amendment 4]
[Document to be Amended] Specification
[Item(s) to be Amended] 0011
[Method of Amendment] Modification
[Proposed Amendment]
[0011] The millimeter wave radar of this invention according to claim 3 is characterized by equipping said pulse modulator with a circulator and equipping said circulator with a control port between input port, an output port, and said input port and output port.
[Procedure amendment 5]
[Document to be Amended] Specification
[Item(s) to be Amended] 0012
[Method of Amendment] Deletion
[Procedure amendment 6]
[Document to be Amended] Specification
[Item(s) to be Amended] 0013
[Method of Amendment] Modification
[Proposed Amendment]

[0013] The millimeter wave radar of this invention according to claim 4 is characterized by said pulse modulator being a frequency-conversion mold pulse modulator.
[Procedure amendment 7]
[Document to be Amended] Specification
[Item(s) to be Amended] 0014
[Method of Amendment] Modification
[Proposed Amendment]
[0014] Frequency conversion of the oscillation signal of a millimeter wave band oscillator is carried out by this description, and it can use the output of one millimeter wave oscillator for the object for transmission, and the local oscillation of a receiver according to it.
[Procedure amendment 8]
[Document to be Amended] Specification
[Item(s) to be Amended] 0015
[Method of Amendment] Modification
[Proposed Amendment]
[0015] The millimeter wave radar of this invention according to claim 5 is characterized by consisting of a mixer which carries out the mixer of a millimeter wave band oscillator, the pulse modulator which carries out pulse modulation of the oscillation signal from this millimeter wave band oscillator, the transmitting antenna which transmits the millimeter wave band signal reflected with said pulse modulator, the receiving antenna which receives the reflected wave reflected by the detection body, and the signal by which pulse modulation was carried out to the input signal received with this receiving antenna with the pulse modulator.
[Procedure amendment 9]
[Document to be Amended] Specification
[Item(s) to be Amended] 0017
[Method of Amendment] Modification
[Proposed Amendment]
[0017] A means to transmit the millimeter wave band signal reflected with said pulse modulator to a transmitting antenna, and to transmit the signal by which pulse modulation was carried out with said pulse modulator to a mixer is characterized [which is a band-pass filter] by the millimeter wave radar of this invention according to claim 6.
[Procedure amendment 10]
[Document to be Amended] Specification
[Item(s) to be Amended] 0018
[Method of Amendment] Modification
[Proposed Amendment]
[0018] According to this description, it can discriminate from the signal sent to a sending signal and a mixer with a band-pass filter, and the output of one millimeter wave oscillator can be used for the object for transmission, and the local oscillation of a receiver.
[Procedure amendment 11]
[Document to be Amended] Specification
[Item(s) to be Amended] 0021
[Method of Amendment] Deletion
[Procedure amendment 12]
[Document to be Amended] Specification
[Item(s) to be Amended] 0022
[Method of Amendment] Modification
[Proposed Amendment]
[0022] Moreover, pulse modulation is performed to coincidence with the rise convert of a millimeter wave signal by impressing a pulse to the high-speed operation component used for a pulse modulator, and impressing a millimeter wave to the input edge port of a pulse modulator.

[Translation done.]